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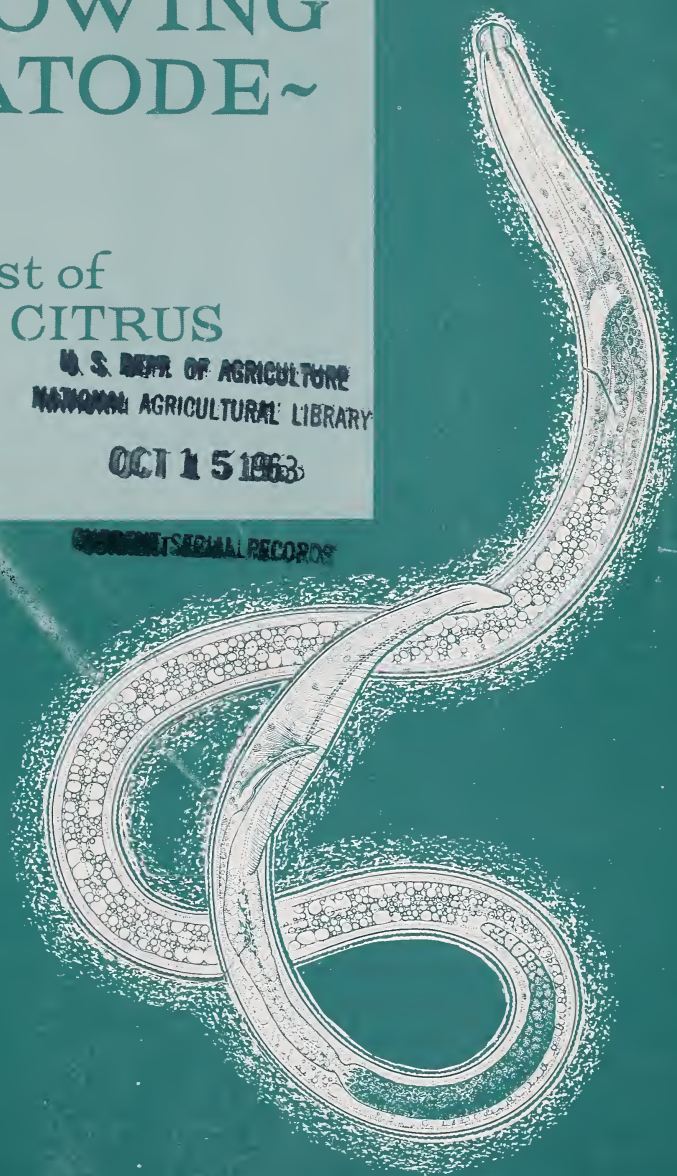
The BURROWING NEMATODE~

A Pest of
CITRUS

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The BURROWING NEMATODE

A Pest of CITRUS

The burrowing nematode¹ is a microscopic eelworm about $\frac{1}{40}$ inch long. It attacks the roots of many tropical and subtropical plants. It was first discovered in banana roots in the Fiji Islands in 1893. Since then it has been found in many countries on a variety of trees, ornamental plants, weeds, grasses, and vegetables. It is known to be a pest of commercial citrus only in Florida, where it attacks citrus trees and causes a disease known as "spreading decline."

Spreading decline was first discovered in a citrus grove near Winter Haven, Fla., in the 1920's. However, it was not until 1953 that research workers of the Florida Citrus Experiment Station established a link between this disease and the burrowing nematode.

Subsequent surveys have shown that burrowing nematodes are present in 31 counties in Florida. Sixteen of these counties have infestations in commercial citrus groves. Polk, Highlands, Orange, and Lake Counties have the largest infested citrus acreage.



Burrowing nematode as seen under a microscope.

¹ *Radopholus similis*.

DAMAGE

Burrowing nematodes damage healthy citrus trees by burrowing into the young feeder roots; there the pests feed and reproduce. Nematode feeding makes trees subject to infection. It encourages the entrance of bacteria and fungi, and these cause root decay. The feeder roots die, and the nematodes spread to healthy roots. Destruction of the feeder roots causes the trees to go into a state of decline.

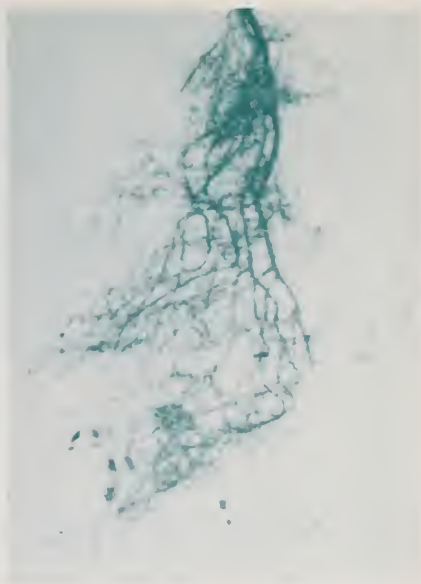
Infested trees usually have a stunted appearance, thin and yellowed foliage, small leaves and fruit, and very low production. They tend to wilt quickly in dry weather, and their blooming is erratic.

Infested trees usually do not die, but they remain in a weak, low-producing condition. Improvement may occur with an increase of moisture or fertilizer, but such improvement is temporary.

Distinct symptoms of spreading decline seldom appear on ornamental plants, weeds, and other hosts of the burrowing nematode. The pest can be detected on these hosts only by microscopic examination.

SPREAD

Natural spread of the burrowing nematode in citrus groves is about 50 feet a year; it is caused by migration of the pest through the soil. Nematodes can be spread to new locations by movement of cultivation equipment, by surface-water drainage, and by transportation of infested soil or infested plant material.



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Citrus roots: Top, from infested tree; bottom, from normal tree.



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Citrus leaves: Left, from infested tree; right, from normal tree.

LIFE HISTORY AND HABITS

The burrowing nematode penetrates the young feeder roots by means of a strong, needlelike feeding tube called a stylet. The pest feeds on plant tissue and juices, depriving the plant of needed nutrition.

The female nematode, after mating, deposits eggs in tunnels that the pest has made in the root tissue of host plants. Eggs hatch in about 8 days, and the newly-hatched larvae begin feeding. Within about 12 days after hatching, the larvae pass through several molts and finally become adults. The life cycle from egg to egg is completed in about 3 weeks; thus, under favorable conditions the populations may build up very rapidly.

Both adults and larvae are capable of moving through the soil. Both stages, except for the adult male, are able to feed on and penetrate healthy roots; the adult male does not injure citrus to any appreciable extent.

PROGRAM OBJECTIVE

The U.S. Department of Agriculture has joined the Florida Department of Agriculture, Division of Plant Industry, in a program to control the burrowing nematode. The objective of the program is to confine the present infestation of this pest within the areas where it occurs. The ultimate goal is the eradication of the nematode from commercial citrus.

There are approximately 7,500 acres of commercial citrus in Florida known to be infested with this pest. Attainment of the program objective will protect the remaining 800,000 acres of noninfested citrus in that State. It also will prevent spread of the nematode to the estimated 300,000 acres of commercial citrus in other States.

CONTROL

Control of burrowing nematodes is accomplished by (1) preventing their spread and (2) eradicating them.

There is no known way of treating trees to prevent infestation, or to save them after they have become infested.

Spread is prevented by placing chemical barriers in the soil to encircle an infested area. The grove owner can continue to harvest fruit from infested trees until they no longer produce a profitable crop. Eradication measures may then be undertaken, and the land returned to profitable productivity.

Eradication is accomplished by the "push and treat" method. In this, the trees in an infested part of a grove are uprooted by a bulldozer. These trees are burned within the "pushed" area.

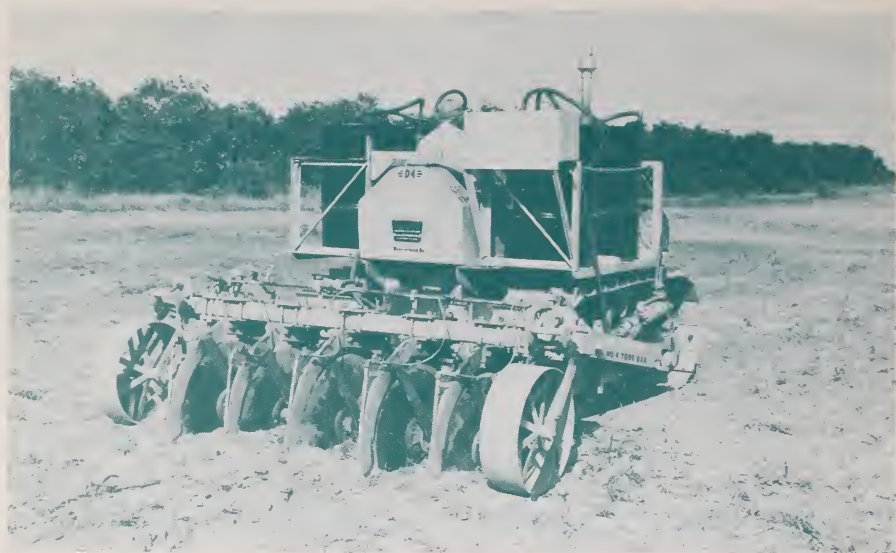
Then the land is chemically treated to kill the nematodes in the soil and in the remaining roots. Clean cultivation must be practiced in treated areas for at least 6 months. If these areas are apparently free of nematodes after two annual inspections, they may be replanted with citrus.

The control method used is determined by grower preference, which is influenced by economic considerations. If the infestation is small (10 percent or less of the property involved) it usually is more feasible to remove the trees and treat the soil than to install a chemical barrier.



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Trees in infested part of grove being bulldozed down. After fallen trees are burned, the area will be treated with soil fumigant.



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Soil fumigant equipment in operation.

SURVEYS

The extent of spread of the nematode in infested groves is determined by examination of root samples from the periphery of the infestation.

After treatment has been applied, additional surveys are made to determine its success. These surveys are along the emplaced chemical barriers, and around the pushed and treated areas. As a further check on the success of treatment, the replanted trees are sampled.

Systematic surveys are also conducted in citrus nurseries and ornamental-plant nurseries to implement the regulation of movement of infested stock to commercial citrus areas. Proposed citrus nursery sites are sampled to prevent planting on infested soil.

REGULATORY MEASURES

New infestations of burrowing nematodes in commercial citrus are often introduced through transportation of infested citrus and ornamental nursery stock. All varieties of citrus nursery stock, and about 150 species of ornamental nursery plants, are known to be susceptible to nematode attack. The transportation of infested nursery stock within Florida is controlled by laws enacted by that State and enforced by the Florida Department of Agriculture, Division of Plant Industry.

Citrus nursery stock from Florida cannot legally be shipped to other States producing commercial citrus. In Florida, citrus nursery stock must be certified free of the burrowing nematode before it can be moved to a com-

mercial citrus area. Stock grown on approved nursery sites is eligible for certification. Infested citrus stock 1½ inches or less in diameter and free of soil can be certified for movement after the roots have been immersed for 10 minutes in water heated to 122° F. Ornamental nursery stock must be certified free of the burrowing nematode when moved to States that specify this requirement in their regulations.

RESEARCH

The control measures described here have been successful in eradicating the burrowing nematode in some areas, and have generally retarded its spread in commercial citrus. However, researchers are seeking to discover new control measures that will be more effective.

It is hoped that an economically practical "in place" treatment of plants can be developed—a treatment that will kill the nematodes without injuring the plants. To this end, materials and methods are being tested continuously by the University of Florida Citrus Experiment Station, Florida Department of Agriculture, and the U.S. Department of Agriculture.

It is also desirable to find a root stock that is resistant to, or tolerant of, the burrowing nematode. Research investigations have developed promising root stocks, but further studies must be conducted before they can definitely be established as suitable for widespread use.

HOW YOU CAN HELP

You can help control the burrowing nematode if you—

1. Learn to recognize symptoms of spreading decline, and report trees that appear to be affected to your county agent, the U.S. Department of Agriculture, or the Florida Department of Agriculture.

2. Help eliminate the burrowing nematode infestation in your area through cooperation with your neighbor.

3. Observe the following cultural procedures:

- Buy only certified citrus nursery stock.

- Always clean cultivation equipment before moving it from infested areas to noninfested areas.

- When removing trees, do not drag them through the grove. If possible, destroy them where they fall.

- Do not cultivate across an emplaced barrier.

- Do not place infested ornamental nursery stock near a commercial citrus grove.

- Before planting certified citrus nursery stock, do not leave it near doorway plants or near an infested grove.

- Make sure that the fill dirt and clay used near your grove comes from noninfested sources.

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Prepared by
PLANT PEST CONTROL DIVISION
AGRICULTURAL RESEARCH SERVICE

Washington, D.C.

Issued September 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 5 cents